New tool maps future climate costs for airlines, passengers

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Industrial and enterprise systems engineering professor Lavanya Marla and her colleagues calculated the relative costs of different methods of responding to flight disruptions caused by higher temperatures in a warming climate. Credit: L. Brian Stauffer

When Phoenix temperatures topped 120 F in June 2017, American

Airlines canceled dozens of flights at a local airport because the airplanes could not take off safely in the extreme heat. Scenarios like this are likely to become more common as a result of climate warming, scientists say, but the operational costs to airlines and passengers are largely unknown.

To fill this gap in knowledge, University of Illinois Urbana-Champaign industrial and enterprise systems engineering professor Lavanya Marla, her Ph.D. student Jane Lee and University of Michigan professor Parth Vaishnav built a mathematical model to calculate how much it will cost airlines to cope with rising temperatures. The model incorporated historical schedule and traffic data; present-day airport design; and airline fleet composition, scheduling and troubleshooting protocols. It used these data in conjunction with future climate projections to calculate the relative costs of different methods of responding to flight disruptions caused by higher temperatures in a warming climate.

Reported in the journal *Transportation Research Part D: Transport and Environment*, the model predicted substantial heat-related expenditures for airlines in 2035 and 2050, the two years analyzed. The researchers used a climate model known as RCP 8.5 in their calculations, determining the added costs for mild, moderate and severe climate projections.

"Lots of people over the last 15 years have looked at how aviation affects climate, but what about the reverse? What is the impact of climate on airline operations?" Marla said. "Our study found that the total aircraft and passenger costs that airlines experience today can increase, on average, anywhere from 29 percent to 49 percent."

Hot air is less dense than cool air. Extremely hot temperatures—typically above 118 F—can affect an airplane's ability to generate enough lift to get off the ground. Smaller aircraft, in particular, may lack sufficient power to overcome this limitation and may have to offload some passengers or cargo to lessen their loads, Marla said. Airlines may switch passengers to larger aircraft or delay takeoff until conditions improve. Shorter runways also cause difficulty in generating enough lift, and airports may consider lengthening them.

Every choice can lead to further disruptions—delayed takeoffs and late arrivals, airplanes idling on the tarmac, inconvenience to passengers and crews, for example—each of which has associated costs.

"Instead of assuming a fixed capacity for an aircraft—that is, the total number of seats—we calculated how that capacity changes based on temperature and which airport you're departing from," Marla said. "And we found that passengers and airlines will be severely impacted as the climate changes."

The new model will allow airlines and airports to determine how their climate-related operational costs will compare with the cost of making strategic investments to adapt to climate change—by building longer runways, for example, or investing in more powerful airplanes, Marla said.

"We wanted to emphasize that adaptation, to some extent, will be needed," she said. "We also wanted to better understand the costs of not doing so."

More information: Jane Lee et al, The impact of climate change on the recoverability of airline networks, *Transportation Research Part D: Transport and Environment* (2021). DOI: 10.1016/j.trd.2021.102801

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